ESTIMATION OF CANCER RISK ASSOCIATED WITH PATIENTS UNDERGOING BRAIN COMPUTED TOMOGRAPHY SCAN IN SOKOTO, NIGERIA

M. Buhari[1], S. Buhari[1]

[1]Department of Physics with Electronics, Federal University Birnin Kebbi, Kebbi, Nigeria

Abstract— **In this research conducted in Sokoto, the aim was to estimate the cancer risks associated with brain computed tomography (CT) scans and find ways to minimize the negative effects of radiation exposure. The study collected data from 100 adult patients with an average weight of 70 ± 10 kg from two centers. The data collected included exposure factors, CT Dose Index ($CTDI_{vol}$), and Dose Length Product (DLP). The effective doses for both centers were assessed using Imaging Performance and Assessment of CT (imPACT) dosimetry software with the National Radiological Protection Board (NRPB) SR-250 dataset. The results showed that the mean effective dose for Center A was 2.8 mSv for males and 2.6 mSv for females, while for Center B, it was 1.4 mSv for males and 1.5 mSv for females. The mean probability of Lifetime Attributable Risk (LAR) of cancer development was calculated as 1 in 515 for males and 1 in 428 for females in Center A, and 1 in 1127 for males and 1 in 914 for females in Center B. The overall estimated cancer risk for all patients in both centers was 1 in 592. The estimated cancer risks in this study were found to be higher than those reported in national and international studies. Therefore, authors of this study emphasize the need for regular quality assurance assessments of the CT machines used in the two centers in Sokoto to prevent overexposure and minimize radiation-related risks to patients. In conclusion, this study highlights the importance of estimating cancer risks associated with brain CT scans and the need for ongoing monitoring and quality assurance to ensure patient safety and minimize radiation exposure.**

Keywords— **Cancer risk, CT scan, Effective dose, and ImPACT CT.**

I. INTRODUCTION

Cancer is a global health concern, and its incidence has been increasing steadily over the years. Diagnostic imaging techniques, such as computed tomography (CT) scans, play a crucial role in the early detection and diagnosis of various medical conditions. However, the use of ionizing radiation in CT scans has raised concerns about potential health risks, particularly the risk of developing cancer. In Nigeria, like many other developing countries, the availability and utilization of CT scans have significantly increased in recent years. However, limited data and research exist regarding the potential radiation-related risks associated with these procedures. Therefore, it becomes imperative to assess the cancer risk associated with patients undergoing brain CT scans in Sokoto, Nigeria. The primary objective of this study is to estimate the cancer risk attributable to ionizing radiation exposure from brain CT scans in Sokoto. By quantifying the potential risks, medical personnel, policymakers, and patients can make informed decisions regarding the use of CT scans and implement appropriate safety measures to minimize radiation-related health hazards.

To achieve this objective, the study employs a prospective cohort design, utilizing data from a sample of patients who have undergone brain CT scans in Sokoto. The sample includes individuals from various age groups, both genders, and with different medical indications for the scan. Information regarding radiation doses, imaging protocols, and patient demographics are collected from medical records and imaging databases. Radiation risk estimation was based on established radiation dosimetry methods and models, which take into account the specific radiation exposure parameters associated with brain CT scans. The estimated cancer risk is expressed as the excess lifetime cancer risk per unit dose of radiation, and the results compared with established international guidelines and reference values.

It is expected that the findings of this study will provide valuable insights into the potential cancer risks associated with brain CT scans in Sokoto, Nigeria. By understanding the magnitude of these risks, healthcare professionals can optimize radiation doses, develop tailored imaging protocols, and implement effective radiation protection measures to ensure patient safety without compromising diagnostic accuracy. Moreover, this research is envisaged to contribute to the limited body of knowledge concerning radiation risks in Nigeria, serving as a foundation for future studies and aiding in the formulation of evidence-based guidelines and policies. Ultimately, the aim is to strike a balance between the diagnostic benefits of CT scans and the associated cancer risks, fostering a culture of radiation safety in medical imaging practices.

This paper presents an introduction to a study focused on estimating the cancer risk associated with patients undergoing brain CT scans in Sokoto, Nigeria. By addressing the gaps in knowledge regarding radiation-related risks and providing evidence-based insights, this research has the potential to significantly impact healthcare practices, radiation safety guidelines, and ultimately, the overall wellbeing of patients in the region.

II. METHODOLOGY

A prospective quantitative research method was chosen to estimate the cancer risk associated with patients undergoing brain CT scan examinations in Sokoto. There was no adjustment of the data collected from the centers.

A) Method of Data Collection

The data was collected using a well-structured data collection sheet designed for the study and the Ethical clearance with code NHREC/30/012/2019 was obtained from the centers. The following information was recorded:

i) Patients' bio data such as age, gender and weight
ii) Scan parameters such as kV, mA, slice thickness, number of slices and pitch factor
iii) Dose description parameters namely, CTDIvol and DLP.

B) Method of Data Analysis

The data were analyzed using SPSS statistics software for estimating mean, range, standard deviation and 75% percentile data. Dosimetry software such as commercially available ImPACT CT patient dosimetry calculator version (1.0.4.xls) was used to calculate the effective dose and this was used in calculating the cancer risk of an individual patient and risk associated with gender at both centers A and B.

III. RESULTS

The LAR of cancer incidence for brain CT examination was varied depending on age, gender and effective dose for every individual CT examination (Tajudeen *et al.*, 2018). The lifetime attributed risk (LAR) of cancer incidence was estimated for different ages and gender from 0.1 Gy equivalent dose using BEIR VII Report Phase 2 (2006). In each case where data was not available for specific age, the matrix interpolation was performed based on the two nearest tabulated ages. The general expression for calculating the LAR of cancer incidence for brain CT with respect to the patient effective dose in (mSv) is given by the mathematical equation.

$$LAR_{at\ an\ age} = \frac{E\ (mSv)}{D} \times \frac{LAR\ cancer\ incident_{at\ an\ age}}{100{,}000}\ \%$$

Where D is equivalent dose equal to 0.1 Gy, constant for adult from 16-80 years that receive effective dose of 0.1-10 mSv (Tajudeen *et al.*, 2018). The statistical summary of the risk of LAR for both male and female at the study centres is presented in (Table 1) and (Table 2), the mean effective dose and estimated lifetime attribute risk of cancer incidence for both male and female for centres A and B is summarized.

Table 1: Mean, range (min & max) dose E and estimated LAR for male patient

Parameters	No of Patients	E (mSv)	LAR %
Centre A			
Mean± SD	32	2.8±1.1	0.1940±0.08
Range		1.1-5.5	0.03-0.38
Centre B			
Mean± SD	17	1.4±0.5	0.0887±0.34
Range		1.0-2.8	0.03-0.31
Total A+B			
Mean± SD	49	2.3±1.2	0.1589±0.08
Range		1.0-5.5	0.03-0.38

Table 1 presents the statistical summary of lifetime attributable cancer risk for male patient in both centers. Centre A recorded the highest mean attributable risk of cancer with 0.1940% and mean effective dose of 2.8 mSv, while Centre B recorded 0.0887% risk with mean effective dose of 1.4 mSv. The combined result shows that male patients recorded 0.1589% of total attributable cancer risk with mean effective dose of 2.3 mSv.

Table 2: Mean, range (min & max) dose E and estimated LAR for female patient

Parameters	No. of Patient	E (mSv)	LAR %
Centre A			
Mean±SD	28	2.6±1.05	0.2335±0.11
Range		0.9-5.5	07-0.510
Centre B			
Mean±SD	23	1.5±0.5	0.1093±0.09
Range		1.0-2.8	0.03-0.17
Total A+B			
Mean±SD	51	2.1±1.0	0.1761±0.12
Range		0.7-5.5	0.03-0.51

Table 2 shows the female LAR, in which Centre A had a highest risk of cancer incidence of 0.02335% with mean effective dose of 2.6 mSv, and Centre B recorded lowest risk of cancer incidence of 0.1093% and mean effective dose of 1.5 mSv. The combined results show that female patient statistics have 0.1761% attributable cancer risk incidence with mean effective dose of 2.1 mSv.

Table 3: Comparison of estimated mean LAR of cancer due to CT brain scan for male and female in study centers

Centres	Male		Female	
	Mean LAR %		Mean LAR %	
A	1 in 515	0.1940	1 in 428	0.2335
B	1 in 1127	0.0887	1 in 914	0.1093
A+B	1 in 629	0.1589	1 in 567	0.1761

Table 3 shows the comparison of LAR of cancer due to CT brain imaging procedure for male and female patients. The mean value of LAR of cancer for male patient is 1 in 515 and for female patient was 1 in 428 for Centre A while male recorded LAR of cancer 1 in 1127 and 1 in 914 for female in Centre B. The cumulative result shows the males had LAR of 1 in 629 and female had 1 in 567 at the study centres. Smith-Bindman *et al.*, (2009), obtained the estimated LAR of cancer for routine head CT in females to be 1 in 8100 and of males to be 1 in 11080. Shaiful (2018) estimated the LAR for head CT as 1 in 248 for males and 1 in 332 for females. From the results, it could be deduced that cancer risk is relatively higher for patients who underwent CT brain imaging in this study.

IV. DISCUSSION

The estimated LAR of cancer was 0.1940% for males and 0.2335% for females in centre A, and 0.0887% for males and 0.1093% for females in centre B. The total LAR of both centers is 0.1589% for male and 0.1761% for female. The approximate percentage for any person to have a cancer was assessed to be 1 in 515 for male and 1 in 428 for female in centre A, while 1 in 1127 for male and 1 in 914 for female in centre B while the total for all the patients in male and female were 1 in 629 male and 1 in 567 females, respectively. For the entire patient population, it was estimated that 1 in 592 patients received a similar effective dose during examination.

The findings of this study show that the statistical summary reveals the age range 21-30, 31-40 and 41-50 years have higher frequency of CT examination, and this could be attributed to the fact that they have percentage risk of cancer incidence, the age group are agile and engaged in many activities that make them susceptible to accident which subjects them to undergo brain CT examinations.

The LAR of cancer incidence also depends on the individual effective dose received by patients and also on the age. Example, people above 65 years are considered weaker healthwise, and hardly survive fatal accidents, largely because many of them might have other ailments such as hypertension, diabetes, and heart related problem, therefore many of them may not live long enough to experience the effects of cancer radiation after exposure to radiation from CT scans.

V. CONCLUSION

This study provides evidence that radiation exposure from commonly performed CT examinations in Sokoto is relatively higher compared to other studies, contributing to a substantially increased risk of cancer. There is therefore the need to optimize CT procedures from this part of Nigeria to ensure patient safety and protection during scanning.

REFERENCES

1. American Association of Physicist in Medicine. (2008). The Measurement, Reporting and Management of Radiation dose in CT. *Report No. 96* One Physics Elipse College park MD, - *pubs.rsna.org*
2. American College of Radiology. (2013). “AAPM” Guideline for diagnostic reference levels and achievable dose in X-ray Imaging, *Resolution – 47, 1-9.*
3. Arif Abdullah. (2009). Establishing dose reference level for computed tomography (CT) in Malaysia. MSc. thesis University Sains Malaysia, Pinang Malaysia. *Retrieve on* 7/02/2020 at: http://eprints.usm.my/15519/1
4. Barnes, E. (2010). CT Doses, Widely Variable in Europe, are reduced by Staff Efforts. Paper Presented at the European Congress of Radiology (ECR). *Retrieve on* 07/02/2020 at: http://www.auntminnie.com.
5. Barry, F. W. (2001). Diagnostic reference levels: the way forward. *British journal of radiology*, 74: 785-788.
6. BEIR VII report. (2006). The Effects on Population of Exposure to Low Levels of Ionizing Radiation, National Academy of Science - National Research Council Advisory Committee on the Biological Effects of Ionizing Radiation (Washington, DC).
7. European Commission. (1996). Guideline on quality criteria for diagnostic radiology images, EUR 16261EN, at: http://www.bookshop.eurpa.eu
8. European Commission. (1999). Guidance on diagnostic reference levels (DRLs) for medical exposures radiation protection 109 Directorate general environment nuclear safety and civil protection, Luxembourg. at: http://www.ec.europu.eu
9. European Commission. (2014). European Guidelines on Quality Criteria for Computed Tomography EUR 16262 EN. European Commission, Luxembourg
10. ICRP. (2007). Recommendation of the international commission on radiological protection *ICRP Publication 103*: *annals of the ICRP 2007*: 37(2-4), Orlando Florida
11. Idris G. (2014). Computed Tomography Dose Index for Head CT in Northern Nigeria. MSc thesis Cape Peninsula University of Technology South Africa
12. Institute of Physics and Engineering in Medicine. (2004). Guidance and establishment and use of diagnostic reference level for medical x-ray examination. *Report 88*, New York.
13. International Atomic Energy Agency. (2013). Radiation protection of patient (RPOP); CT optimization international atomic energy agency. *Vienna international centre* P.O Box 100, 140 Vienna Austria
14. International Electro-technical Commission, (2001). Specification for Document management system, Principle and method (IEC – 820451: 2001). Chapter 7
15. Tabari, A. M., and Idris, G. (2007). Diagnostic yield of cranial computed tomography scan in kano, Nigeria. *Nigerian journal of basic and clinical science* 4(12): 22-25.
16. Tajudeen, A. O., Caleb, A. A., Fatai, A. B., Sulaiman, A. O., Aminu, S., and Mark, B. I. (2018). Patient-specific radiation dose and cancer risk in computed tomography tomography in Ondo, *Nigeria. Iranian journal of medical physics*, Retrieve on 20/08/2020.

Contacts of the corresponding author:

Author: Buhari Maidamma
Institute: Federal University Birnin Kebbi
City: Kebbi
Country: Nigeria
Email: buhari.maidamma@fubk.edu.ng